2021 Annual Evaluation Report – Volume I Portfolio Summary

Prepared for PSEG-LI

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PREFACE

GLOSSARY OF TERMS

Key Term	Definition
Delta MWh	The total change in annual electric energy consumption. Equal to $MWh_{ee} - MWh_{be}$. A negative value of Delta MWh indicates the measure or program increases electric consumption on the PSEG Long Island system as a whole. A positive value of Delta MWh indicates the measure or program reduces electric consumption on the PSEG Long Island system.
Discount Rate	The time value of money is used to calculate the present value of future benefits and costs. PSEG Long Island uses a weighted average cost of capital supplied by LIPA that represents the cost of borrowing to build additional capacity to meet the service territory's future supply needs. Based on these factors, we used a nominal discount rate of 5.66% in the 2021 evaluation.
Ex-Ante Gross Savings	The energy and demand savings recorded by the implementation contractor in the program tracking database. Ex-ante gross savings are sometimes referred to as claimed savings.
Ex-Post Gross Savings	The energy and demand savings estimated by the evaluation team, using the best methods and data available at the time of the evaluation.
Ex-Post Net Savings	The savings realized by the program after independent evaluation determines ex-post gross savings and applies NTGRs and line losses. The evaluation team uses the ex-post net impacts in the cost-effectiveness calculation to reflect the current best industry practices.
Gross Impacts	The change in energy consumption or demand directly due to the participants' program-related actions, regardless of why they participated. These impacts include coincidence factors (CFs) for demand, waste-heat factors, and installation rates. Gross impacts presented in this report do not include line losses and, therefore, represent the energy and demand savings as would be measured at the customers' meters.
kW Impacts (Demand or Capacity)	The reduction in demand coincident with system peaking conditions due to energy efficiency measures. For Long Island, system peaking conditions typically occur on non-holiday summer weekdays. This report's peak demand savings values are based on system coincident demand impacts between 4 pm and 5 pm on non-holiday weekdays from June to August.
MWh Beneficial Electrification (MWh_{be})	The increase in weather-normalized annual electric energy consumption attributable to beneficial electrification measures.

Key Term	Definition
MWh Energy Efficiency (MWh_{ee})	The reduction in weather-normalized annual electric energy consumption attributable to energy efficiency programs or measures.
Levelized Cost of Capacity	To operate the electric grid, the system operator needs installed, operable capacity to meet peak demand conditions. The levelized cost of capacity is a metric that allows planners to compare the costs of different resources to meet (or lower) peak demand. The metric is typically expressed in terms of $kW/year.
Levelized Cost of Energy	The equivalent cost of energy (kWh) over the life of the equipment that yields the same present value of costs, using a nominal discount rate of 6.16%. The levelized cost of energy is a measure of the program administrator's program costs in a form that planners can compare to the cost of supply additions.
Line Loss Factor	The evaluation team applies line losses of 5.67% on energy consumption (resulting in a multiplier of 1.0601 = [1 ÷ (1 – 0.0567)]) and of 7.19% on peak demand (resulting in a multiplier of 1.0775 = [1 ÷ (1 – 0.0719)]) to estimate energy and demand savings at the power plant.
MMBtu Beneficial Electrification ($MMBtu_{be}$)	For fuel-switching measures, the reduction in site-level fossil fuel consumption minus the site level increase in the electric consumption (MWh_{be}) converted to MMBtu at 3.412 MMBtu per MWh.
MMBtu Energy Efficiency ($MMBtu_{ee}$)	The reduction in site-level energy consumption due to energy efficiency expressed on a common MMBtu basis. $MMBtu_{ee}$ impacts are calculated by multiplying the MWh_{ee} impacts by a static 3.412 MMBtu per kWh conversion factor and adding any fossil fuel conservation attributable to the measure. Secondary fossil fuel impacts, such as the waste heat penalty associated with LED lighting, are also deducted from the $MMBtu_{ee}$ estimates.
Net Impacts	The change in energy consumption or demand that results directly from program-related actions taken by customers (both program participants and non-participants) that would not have occurred absent the program. The difference between the gross and net impacts is the application of the net-to-gross ratio (NTGR) and line losses. Net impacts presented in this report also include line losses and, therefore, represent the energy and demand savings as would be measured at the generator. Net impacts are used for cost-effectiveness analysis.
Net-to-Gross Ratio (Free-Ridership and Spillover)	The factor that, when multiplied by the gross impacts, provides the net impacts for a program before any adjustments for line losses. The NTGR is defined as the savings attributable to programmatic activity after accounting for free-ridership (FR) and spillover (SO). Free-ridership reduces the ratio to account for those customers who would have installed an energy-efficient measure without a program. The free-ridership component of the NTGR can be viewed as a measure of naturally occurring energy efficiency. Spillover increases the NTGR to account for non-participants who install energy-efficient measures or reduce energy use due to the actions of the program. The NTGR is generally expressed as a decimal and quantified through the following equation: NTGR = 1 – FR + SO

Key Term	Definition
Realization Rate	The ratio of ex-post gross to ex-ante gross impacts. This metric expresses the evaluation savings as a percentage of ex-ante savings claimed by PSEG Long Island or the implementation contractor. The Home Energy Management program is implemented by Uplight on behalf of PSEG Long Island. TRC and its subcontractors implement the remainder of the portfolio.
Societal Cost Test (SCT)	A test that measures an energy efficiency program's net costs as a resource option based on benefits and costs to New York. Rebate costs are not included in this test because they are assumed to be a societal transfer. To maintain consistency with the most current version of the New York Benefit-Cost Analysis Handbook, we applied the SCT as a primary method of determining cost-effectiveness using the same assumptions as those used by PSEG Long Island's resource planning team.
Technical Reference Manual (TRM)	A collection of algorithms and assumptions used to calculate resource impacts of PSEG Long Island's Energy Efficiency Portfolio. The PSEG Long Island TRM aligns with the New York State TRM in many respects but includes Long Island specific parameters and assumptions where available from saturation studies or prior evaluation research.
Total MMBtu Impact	The primary performance metric for 2020. Equal to the sum of $MMBtu_{be}$ and $MMBtu_{ee}$. This metric represents the change in site-level fuel consumption attributable to the measure or program. This metric does not consider the amount of MMBtu required to generate a kWh of electricity – only the embedded energy in the delivered energy.
Utility Cost Test (UCT)	A test that measures the net costs of an energy efficiency program as a resource option, based on the costs that the program administrator incurs (including incentive costs) and excluding any net costs incurred by the participant. To allow for direct comparison with PSEG Long Island's assessment of all supply-side options and consistent with previous evaluation reports, we continue to show the UCT as a secondary method of determining cost-effectiveness.
Verified Ex-Ante Gross Savings	A key question is if the ex-ante gross energy impacts claimed by the implementation contractors were calculated consistently using the calculations and assumptions approved by PSEG Long Island and LIPA and used to develop annual savings goals. To verify claimed savings, the evaluation team independently calculates the saving using the calculations and assumptions pre-approved by PSEG Long Island. These savings estimates are used to determine if PSEG Long Island achieves its annual scorecard goals.

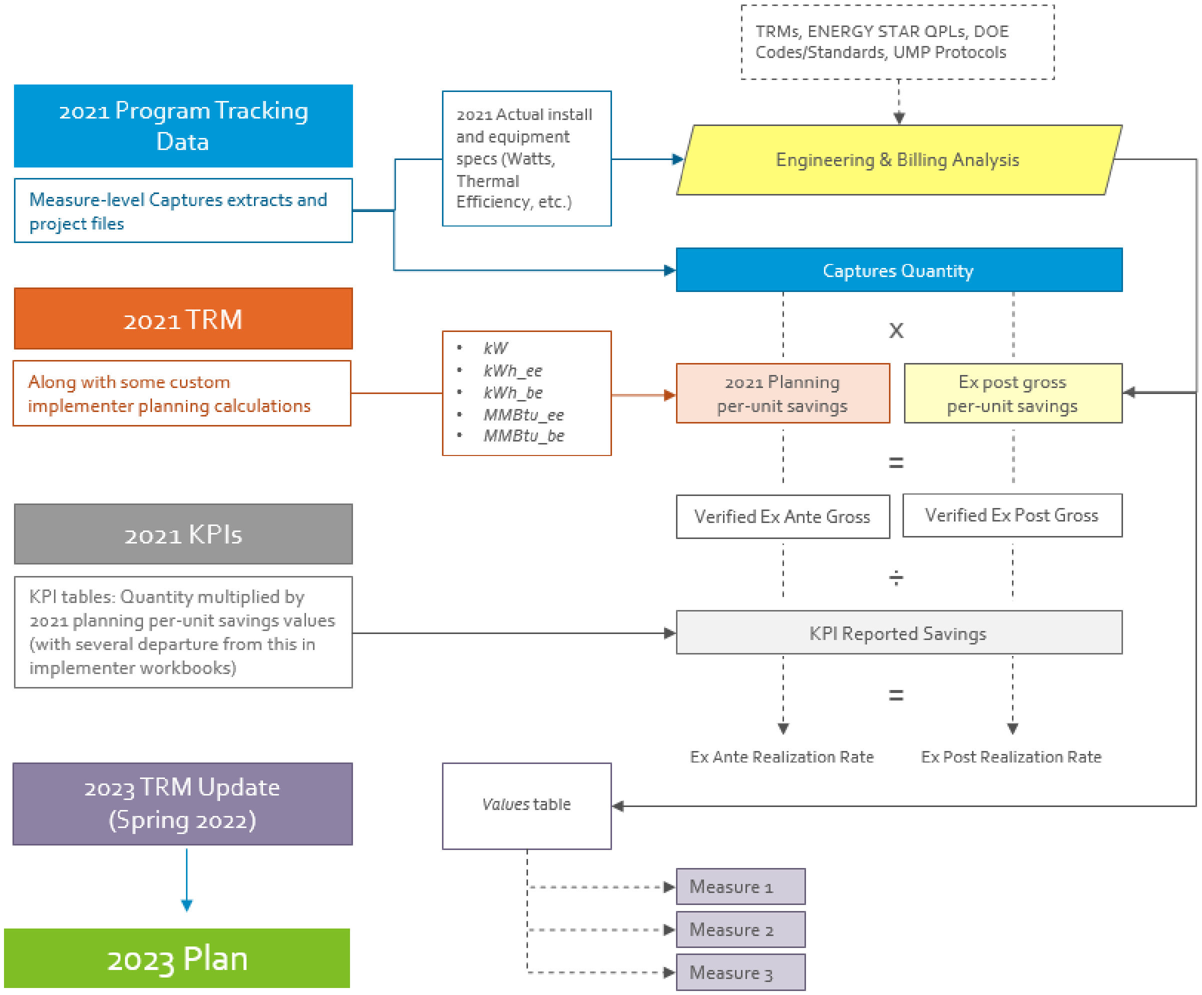
ANNUAL EVALUATION TASKS AND CYCLE TIMELINE

Figure 1 outlines annual energy efficiency and beneficial electrification programming timeline for planning, verified ex-ante, and verified ex-post as well as the resources that inform assumptions for each deliverable. The verified ex-ante audit asks if the ex-ante gross energy impacts claimed by the implementation contractors were calculated consistently using the calculations and assumptions approved by PSEG Long Island and LIPA. To verify claimed savings, the evaluation team independently calculates the saving using the calculations and assumptions pre-approved by PSEG Long Island. These savings estimates are used to determine if PSEG Long Island achieves its annual scorecard goals, and results are submitted in the Verified Ex-Ante Memo, included in Appendix D.

Volumes I and II of this report outline the results from the ex-post evaluation. The ex-post evaluation estimates energy and demand savings for the portfolio using the most current methods and data available at the time of the evaluation. Assumptions and algorithms from the most up-to-date TRMs, DOE Codes and Standards, and other sources are utilized in this portion of the evaluation. The output informs recommendations for future planning cycles.

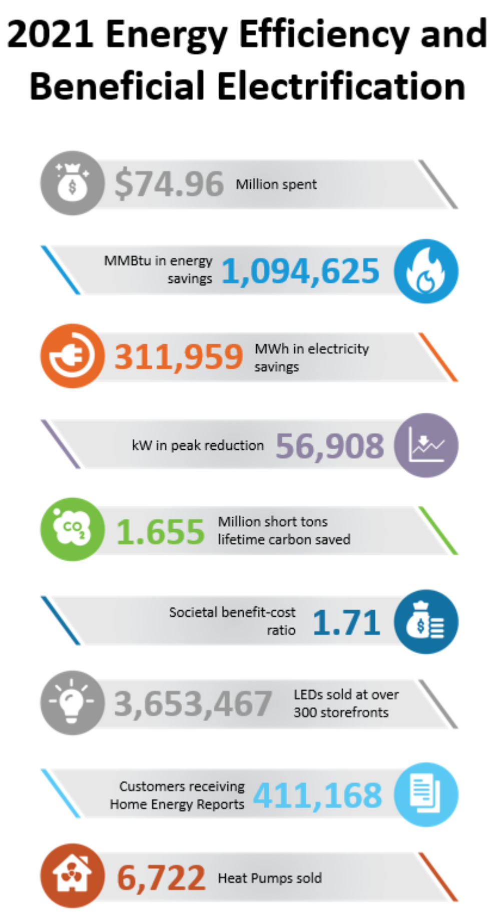
It is important to note that the feedback loop is a nearly two-year cycle. PSEG Long Island has already established 2022 goals and planning assumptions, therefore findings and recommendations from the 2021 ex-post evaluation will not be reflected in the 2022 program claimed savings methodology. The findings and recommendations of this 2021 impact evaluation will be reflected in 2023 planning assumptions, goal setting, and ex-ante savings values. Additionally, major drivers in differences between ex-post and claimed ex-ante savings discovered in the 2020 evaluation were expected to persist in the 2021 evaluation results.

Figure 1: Annual Evaluation Data Flow



1 INTRODUCTION

PSEG Long Island's Energy Efficiency programs offer a wide array of incentives, rebates, and programs to PSEG Long Island residential and commercial customers to assist them in reducing their energy usage and thereby lowering their energy bills. The Energy Efficiency and Beneficial Electrification Portfolio is administered by PSEG Long Island and its subcontractor, TRC, on behalf of the Long Island Power Authority (LIPA). The sole exception is the residential behavioral program, Home Energy Management (HEM), which is administered by Uplight. This report presents the 2021 Energy Efficiency and Beneficial Electrification Portfolio program evaluation ex-post gross results and covers the period from January 1, 2021 to December 31, 2021.



The Demand Side Analytics evaluation team produced two volumes that together compose the entire Annual Evaluation Report. This document, the 2021 Annual Evaluation Report (Volume I) provides an overview of the portfolio-level evaluation findings. The 2021 Program Guidance Document (Volume II), provides detailed program-by-program impact analysis results.

In 2021, PSEG Long Island spent $74.96 million implementing the Energy Efficiency and Beneficial Electrification Portfolio. The investment led to 1,094,625 of total MMBtu savings and avoided 1.655 million short tons of CO2 emissions – the equivalent of removing over 321,000 combustion engine cars for a year.[1] PSEG Long Island's efforts led to $209 million in net societal benefits, with a societal benefit cost ratio of 1.71. Overall, the 2021 activities reduced Long Island's electricity use by 1.56% and peak demand by 0.85%.

As part of its overall goal of reducing GHG emissions 40% by 2030, New York set new statewide energy efficiency targets in the New Efficiency New York (NENY) Order in 2018. The New York goals establish savings targets on an energy (Btu) basis for the State of New York. By laying out these targets, New York established fuel-neutral metrics to incorporate beneficial electrification in the building and transportation sectors, which is necessary to achieve the State's carbon reduction goals. In response, PSEG Long Island:

[1] The EPA estimates 4.6 metric tons of carbon per vehicle-year, the equivalent of 5.15 short tons per vehicle-year. See: https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

- **Included beneficial electrification measures in its offerings.** PSEG Long Island expanded energy efficiency programs to include rebates and incentives for customers to install measures that supply beneficial electrification to the grid, such as heat pumps, and allow customers to save on their fossil fuel-based costs. Adopting fuel-neutral savings targets allows PSEG Long Island to aggregate efficiency achievements across electricity, natural gas, and delivered fuels such as oil and propane, which in turn shifts investment towards more non-lighting opportunities.
- **Changed its primary performance metric from electric energy (kWh) and peak demand (kW) to MMBtu.** The switch allows PSEG Long Island to pursue beneficial electrification measures like heat pumps that increase electric consumption but lower overall energy consumption and emissions. The MMBtu performance metric is "MMBtu at the site" meaning saved or increased kWh is converted to MMBtu using a static factor of 3.412 MMBtu per MWh - the thermal efficiency of the electric power generation fleet does not affect the calculations. 2021 was the second program year in the switch from electric energy to MMBtu. The transition was overall quite successful, and most of the variation between ex-ante and ex-post evaluated savings are attributable to this fundamental shift in resource accounting and the two-year lag between planning and evaluation.

Energy efficiency programs undergo a yearly cycle including planning, implementation, audit and verifications, evaluation, and cost-effectiveness. At each stage, the term "energy savings" is used, leading to the need to be precise about the type of savings. Because energy efficiency has a unique lexicon, we include a comprehensive Glossary of Terms with definitions and encourage readers who are less familiar with the key terms to review them.

Figure 2 below shows the energy efficiency program cycle, the main objectives at each step, and the key terms. The feedback loop is a nearly two-year cycle. The planning activities for 2021 which set the goals, rules, and algorithms for calculating energy savings were conducted in 2020. 2020 was the first program year PSEG Long Island used MMBtu as its primary performance metric. The 2020 energy efficiency and beneficial electrification measures were not evaluated until the spring of 2021, meaning 2021 programs were already being implemented before performance metrics were available for the first year of MMBtu impact programming. Considering this lag, we expected major drivers in differences between claimed savings and ex-post impacts that were discussed in the 2020 evaluation to persist into 2021. Additionally, the findings and recommendations of this 2021 impact evaluation will be reflected in 2023, not 2022, planning assumptions, goal setting, and ex-ante savings values since PSEG Long Island has already established 2022 goals and planning assumptions.

Figure 2: Energy Efficiency Cycle, Objectives, and Key Terms

	Planning	Implementation	Audit & Verification	Evaluation	Cost-Effectiveness
Objective	Set goals for future years and set rules for how savings will be calculated for settlement with implementer	Recruit participants, maximize energy savings, and track activities	Determine if the Implementer used the assumptions and calculations pre-approved by PSEG Long Island	Produce the best after-the-fact estimate of savings delivered using the best methods and data available.	Assess if the portfolio of energy efficiency activities was cost-effective from a (New York) societal perspective using Ex-Post Net savings
Timeline	• **Spring 2020**: Planning for 2021 using draft 2021 TRM assumptions.	• **2021**: Portfolio Programs implemented	• **January 2022**: Verified Ex-Ante Savings Calculated using assumptions from 2020	• **Spring 2022**: Ex-Post evaluation of 2021 portfolio using most up-to-date methods (including PSEG-LI TRMs 2020-2022, NYS TRMs v8 and v9)	• **Spring 2022**: Using Ex-Post Net evaluation values
Key terms	• Planned Savings • Technical Resource Manual (TRM)	• Gross Ex-ante Savings (Claimed Savings)	• Verified Ex-Ante Savings	• Ex-post Gross Savings • Ex-Post Net Savings • Realization Rate • Net-to-Gross Ratio (NTGR)	• Societal Cost Test (SCT) • Utility Cost Test (UCT) • Levelized Cost of Energy • Levelized Cost of Capacity

Throughout the 2021 program year, the COVID-19 pandemic continued to affect all aspects of life. While onsite work resumed for many workplaces in the summer of 2020, various waves of COVID-19 variants created extra barriers and difficulties in implementing measures through the energy efficiency and beneficial electrification portfolio. Additionally, with remote work or hybrid work models becoming more permanent, fundamental shifts in customer behaviors should be taken into consideration. With a strong housing market, customers continuing to work from home, and customers trading vacations for home improvement projects, a renewed appetite for home improvements might prove a beneficial target for the energy efficiency and beneficial electrification portfolio implementers. Despite any potential disruptions to program delivery, PSEG Long Island showed strong performance compared to goals.

In 2021, PSEG Long Island administered six programs, described in Table 1.

Table 1: Energy Efficiency and Beneficial Electrification Program Descriptions

Program	Description
Commercial Efficiency Program	The program assists non-residential customers in saving energy by offering customers rebates and incentives to install energy conservation measures as well as beneficial electrification measures. In addition, Technical Assistance rebates are available under the CEP to offset the cost of engineering and design services for qualifying projects.
Energy Efficient Products	The program's objective is to increase the purchase and use of energy-efficient appliances and lighting among PSEG Long Island residential customers. The

Program	Description
	program provides rebates or incentives for ENERGY STAR® certified lighting and appliances through upstream and downstream promotions. This program also supported Beneficial Electrification measures such as heat pumps. The program supports the stocking, sale, and promotion of efficient residential products at retail locations.
Home Energy Management	Home energy reports are behavioral interventions designed to encourage energy conservation by leveraging behavioral psychology and social norms. The paper or electronic reports compare a customer's energy consumption to similar neighboring households and provide targeted tips on reducing energy use.
Home Comfort	The Residential "Home Comfort" HVAC program, formerly the Cool Homes Program, aims to reduce the energy usage of residential customers with heat pumps. The program seeks to influence PSEG Long Island customers to make high-efficiency choices when purchasing and installing ENERGY STAR ducted air-source heat pumps (ASHP), ductless mini split heat pumps, and ground source heat pumps (GSHP). Using a single application for all measures (heat pumps and weatherization), the Program seeks to promote Whole House solutions. The program has established strong business partnerships with heating and cooling contractors, manufacturers, and program support contractors.
Home Performance	The program serves residential customers and has two main branches: Home Performance with ENERGY STAR® and Home Performance Direct Install. The goal of the Home Performance with ENERGY STAR® Program (HPwES) is to reduce the carbon footprint of customers who utilize gas, oil, or propane as a primary heat source. The Home Performance Direct Install targets customers with electric heating and includes an energy assessment and select free efficiency upgrades. After the free direct install measures are delivered, customers receive a free home energy assessment and are eligible for HPwES rebates.
Residential Energy Affordability Partnership	The program is designed for income-eligible customers and aims to save energy, provide education, help participants reduce electric bills, and make their homes healthier and safer. This program encourages whole-house improvements to existing homes by promoting home energy surveys and comprehensive home assessment services identifying potential efficiency improvements at no cost to the customer.

The remainder of the portfolio report presents the results and key findings. Section 2 summarizes the energy savings and performance. Section 3 presents the portfolio cost-effectiveness and economic impacts. Finally, Section 4 outlines trends and upcoming changes in beneficial electrification and energy efficiency planning considerations.

2 ENERGY SAVINGS AND PERFORMANCE

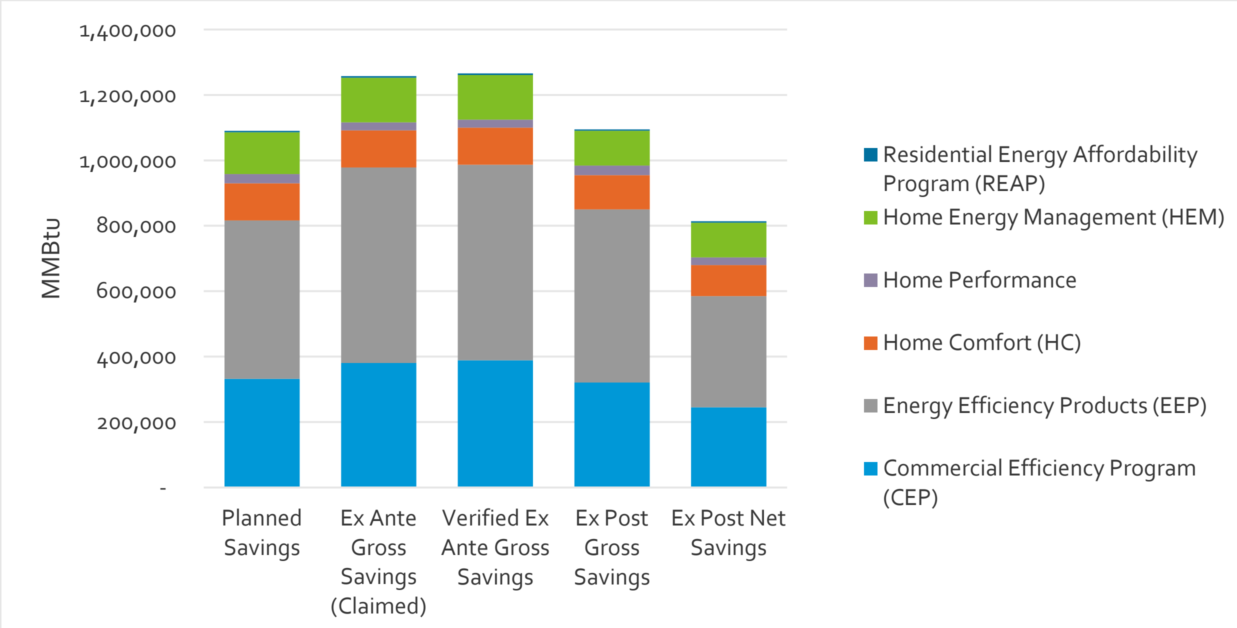
Table 2 below compares planned, claimed, verified, and ex-post gross and net savings under the primary performance metric, MMBtu. A few observations stand out. The claimed and verified ex-ante values exceeded planning targets for all programs except Home Performance. Implementation contractor performance is to be judged using the verified ex-ante metric. For the verified ex-ante metric, the evaluation team independently verified that the main contractor, TRC, calculated the savings consistently with the algorithms and assumptions used for planning. Results of the Verified Ex-Ante Memo can be reviewed in Appendix D.

Table 2: Summary of 2021 Energy Program Performance

Sector	Program	Planned Savings (Goals)	Ex-Ante Gross Savings (Claimed)	Verified Ex-Ante Gross Savings	Ex-Post Gross Savings (Evaluated)	Ex-Post Net Savings
		MMBtu	MMBtu	MMBtu	MMBtu	MMBtu
Commercial	Commercial Efficiency Program (CEP)	332,125	380,534	388,871	321,096	245,042
Residential	Energy Efficiency Products (EEP)	484,059	597,662	597,646	529,226	339,821
	Home Comfort (HC)	113,425	113,615	113,544	104,455	95,001
	Home Performance	28,760	24,307	24,307	29,435	23,449
	Home Energy Management (HEM)	127,374	136,606	136,606	106,447	106,447
	Residential Energy Affordability Program (REAP)	4,532	4,648	4,650	3,966	3,966
Subtotal Commercial:		332,125	380,534	388,871	321,096	245,042
Subtotal Residential:		758,150	876,838	876,753	773,529	568,684
Total Portfolio:		**1,090,275**	**1,257,372**	**1,265,623**	**1,094,625**	**813,726**

Figure 3 and Figure 4 visualize the program performance. Because the goals are based on MMBtu gross savings, the appropriate comparisons are between MMBtu planned, claimed, and ex-post gross savings. Appendix B provides the energy (MWh) and demand (kW) savings to facilitate comparison with prior years. We caution that measures that reduce fossil fuel use, such as heat pumps and heat pump water heaters, can increase electricity consumption and peak demand (kW) metrics.

Figure 3: Portfolio MMBtu Savings



The ex-post results are driven by a handful of measures in the three most prominent programs, Energy Efficient Product (EEP), Commercial Efficiency Program (CEP), and Home Energy Management (HEM). Most of these drivers were identified in the 2020 program year evaluation. With the inherent lag in the evaluation and planning cycle, these differences were expected to persist in the 2021 evaluation. Adjustments to address these major drivers were incorporated into the 2022 program year plan.

Figure 4 visualizes how evaluated savings compare to claimed savings (the Realization Rate), how evaluated savings compare to planned savings, and how claimed savings compare to planned savings. The size of the circle in the plots is scaled based on the goals for the program. At the portfolio level, the ex-post gross savings over planned savings was 100%. This indicates that, in aggregate, the energy efficiency and beneficial electrification programs met PSEG Long Island's goals for 2021. Please note, for Home Comfort the ratio for both the Ex-Post Gross/Goals and Ex-Post Gross/Ex-Ante Gross was 92%, so they overlap perfectly in the chart below.

Figure 4: Portfolio Performance Metrics

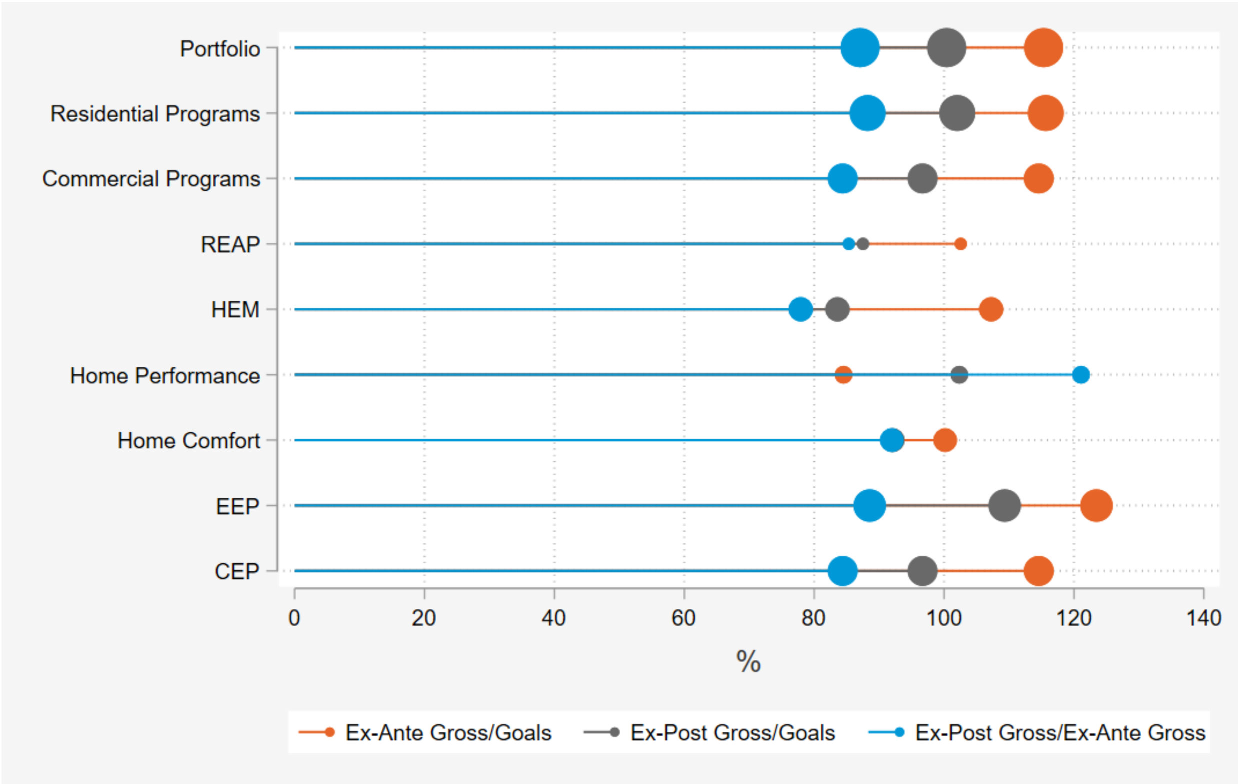


Table 3 summarizes the primary reasons as to why portfolio ex-post gross (evaluated) savings departed from the planned and claimed savings. As Table 3 shows, the biggest drivers of the gap between claimed and ex-post gross savings are the results for EEP, CEP, and HEM. For EEP, the main driver for differences between claimed and ex-post evaluated results are heat pump pool heaters, a carryover issue identified as part of the 2020 evaluation. For CEP, the gap between claimed and ex-post gross (evaluated) saving is the application of waste heat factors, a carryover issue arising due to the shift from electricity (MWh) and peak demand (kW) metrics to at-site MMBtu. For HEM, the actual average savings per household were lower than planned driving down evaluated savings.

These three items led to a 179,116 MMBtu decrease between ex-ante gross and ex-post gross savings. The portfolio level difference between ex-ante gross and ex-post gross was 162,747 MMBtu, meaning that absent these three items the rest of the portfolio had a realization rate greater than 100%. As noted earlier, the change in the primary performance metric from electric energy (MWh) and peak demand (kW) to MMBtu required significant modifications to PSEG Long Island's planning, tracking, and reporting infrastructure. These issues were also primary drivers of portfolio realization rate in the 2020 evaluation. With the lag in the cycle of planning and evaluation, these differences persisted in 2021 but have been updated for 2022. The 2021 evaluation didn't uncover any new large drivers of variance between ex-post gross and ex-ante gross.

Table 3: Summary of Differences between Ex-Post and Ex-Ante

Portfolio Component	Difference Between Ex-Ante Gross and Ex-Post MMBtu Savings	Summary of Savings Difference
EEP Heat Pump Pool Heaters	▪ Ex-post gross < ex-ante gross ▪ 91,613 MMBtu difference ▪ 38% Measure Realization Rate	▪ The 2021 evaluation found that the assumed heat delivery of electric baseline pool heaters was overstated in the ex-ante savings assumptions. This was a key finding from the 2020 evaluation. However, since 2021 planning assumptions were finalized before the 2020 evaluation was completed, the 2021 evaluation shows the same variance between ex-ante and ex-post as the 2020 evaluation. The realization rate volatility for heat pump pool heaters should lessen considerably in 2022 once planning assumptions are aligned with these findings. ▪ The actual efficiency of HPPH rebated in 2021 was higher than planning assumptions (COP = 5.98 versus 5.0). Using the actual efficiency values increases MMBtu savings.
CEP Comprehensive and Fast Track Lighting Calculations	▪ Ex-post gross < ex-ante gross ▪ 57,344 MMBtu difference ▪ 78% Realization Rate for two measures	▪ For most of 2021, heating system impacts from reduced waste heat were not considered in ex-ante MMBtu savings calculations. This was observed in the 2020 program evaluation and was expected to persist into the 2021 program year. ▪ In Q4-2021, PSEG Long Island incorporated waste heat factors into the commercial lighting savings algorithms. We expect the realization rate to increase in 2022 once this change is fully reflected in ex-ante savings claims.
Home Energy Management	▪ Ex-post gross < ex-ante gross ▪ 30,159 MMBtu difference ▪ 78% Realization Rate	▪ The 2021 realization rate for HEM was closer to 100% than 2020 but ex-post savings still fell short of ex-ante claims. ▪ The average savings per household for 2021 was 76 kWh, which is approximately 10% lower than the planned savings of 85 kWh per household, despite issuing more reports than planned. ▪ PSEG Long Island claims ex-ante savings based on the number of reports sent over the year and an assumed savings per report. We recommend that PSEG Long Island adjust their ex-ante calculation method to key off the number of

Portfolio Component	Difference Between Ex-Ante Gross and Ex-Post MMBtu Savings	Summary of Savings Difference
		households receiving reports. This change will make the ex-ante claimed savings less sensitive to the actual number of reports issued.

3 COST-EFFECTIVENESS & ECONOMIC MODELING

Cost-effectiveness analysis is a widely applied tool designed to allow for direct comparison across resource options and to provide a basis for prioritizing investments. The main goal is to facilitate a more efficient allocation of resources by using a common metric – net benefits or the benefit-cost ratio – to compare alternative options. Decision-makers typically apply cost-effectiveness analysis on a forward-looking basis to investments with significant upfront costs but with benefits that accrue over multiple years. It also requires a pre-specified perspective (e.g., societal, utility, program participant, non-participating ratepayer) since different parties can view the same outcome differently.

In this report, however, cost-effectiveness is applied retrospectively to answer the following questions:

- Were the 2021 energy efficiency and beneficial electrification activities and investments cost-effective in retrospect?
- How did cost-effectiveness vary by program?
- How sensitive are cost-effectiveness results to key inputs?

Typically, cost-effectiveness analysis focuses on whether specific policies or programs lead to overall improvements in welfare for society – whether benefits outweigh costs. When benefits outweigh costs, all relevant stakeholders could be made better off through appropriate redistribution. However, policies and programs often produce winners and losers. What counts as a benefit and as a cost often depends on the test perspective. For example, lower prices are typically favorable from a customer's perspective but can mean reduced profit margins from a producer's perspective. A widely accepted industry practice is to assess energy efficiency and demand response programs from multiple perspectives. Depending on the perspective, certain benefits do or do not accrue, and costs under one viewpoint can be viewed as transfers from another.

In New York, the primary metric for screening portfolios for cost-effectiveness is the Societal Cost Test (SCT), which includes benefits accrued to New York as a whole. The perspective enables New York to factor in the avoided costs of energy production and delivery and carbon impacts. It also enables the inclusion of beneficial electrification technologies that increase electricity use but lead to overall lower energy consumption or reduced carbon impacts by shifting energy use from fossil fuels (fuel oil, propane, and natural gas) to electricity. Finally, the SCT considers the full incremental measure costs.[2]

Consistent with PSEG Long Island's Benefit-Cost Analysis (BCA) Handbook, we applied the SCT test as the primary method of determining cost-effectiveness. We also ensured that key assumptions including avoided costs, discount rates, and line losses match those used for PSEG Long Island's latest Utility 2.0 filing.

[2] Incremental costs are defined as the efficient measure cost (including labor) minus the equipment and labor costs of any baseline measure(s) that would otherwise have been installed. In the few cases where incentives surpass incremental costs, the incentive cost is included in the Societal Cost Test rather than the incremental measure cost.

In addition, all calculated benefits and cost benefit ratios reflect net impacts. Net impacts are the change in energy consumption or demand that results directly from program-related actions taken by customers (both program participants and non-participants) that would not have occurred absent the program. The difference between the gross and net impacts is the application of the net-to-gross ratio (NTGR). Net impacts presented in this report also include line losses and, therefore, represent the energy and demand savings as would be measured at the generator.

Critical drivers of portfolio SCT ratio and net benefit changes in 2021 compared to prior years include:

- **Increases to heat pump measures incremental costs**: analysis of actual project costs and baseline measure costs was leveraged to update incremental cost assumptions. The updated costs were applied to ducted and ductless heat pump measures under the Home Comfort and Home Performance programs. This put some downward pressure on the societal cost test results for each but does not change overall screening results.
- **Overall improvement in EEP measure levelized costs**: While the societal cost results improved noticeably for the EEP program it was not due to any single assumption, but rather a move away from less cost-effective measures and an overall improvement in the cost-effectiveness of remaining measures.

3.1 COST-EFFECTIVENESS RESULTS

Table 4 presents the benefit-cost results for the portfolio and for each program using the primary Societal Cost Test perspective. The portfolio-level SCT values are 1.22 and 2.13 for Commercial and Residential Energy Efficiency programs, respectively. The full energy efficiency portfolio SCT value is 1.71. From a societal perspective the Energy Efficiency and Beneficial Electrification Portfolio is cost-effective. The Commercial subtotal is close to 1.0 and the Residential program subtotal is well over 1.0 (a benefit/cost ratio greater than 1 indicates that portfolio benefits outweigh costs).

Table 4: Societal Cost Test Results for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	NPV Benefits ($1,000)	Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$63,555	$51,982	1.22
Residential	Energy Efficient Products	$96,878	$28,264	3.43
	Home Comfort	$36,893	$22,264	1.66
	Residential Energy Affordability Partnership	$1,127	$1,517	0.74
	Home Performance	$7,928	$13,611	0.58
	Home Energy Management	$2,868	$2,691	1.07
Total Residential Portfolio:		$145,695	$68,326	2.13
Total Portfolio[1]:		**$209,250**	**$122,182**	**1.71**

[1] Portfolio costs include $1.87M of advertising that was not allocated to individual programs

Figure 5 shows SCT ratios for each program. Note that the size of markers are proportional to the planned MMBtu savings for each program. The SCT ratio was less than 1.0 for two programs in 2021: REAP and Home Performance, though the reasons for each and the change relative to prior years vary by program. Some key observations are:

- **CEP**: The SCT ratio for CEP is 1.22 in 2021. Because it is close to 1.0, all inputs have the potential to tip the outcome. SCT results for the CEP are driven substantially by incremental costs which are largely a function of project costs. However, the project costs are high relative to energy savings compared to the rest of the portfolio. These higher costs lead to a lower SCT ratio for CEP compared to other programs. Further, administrative costs are about a quarter of total costs at the portfolio level. Given that energy savings are relatively low compared to the incremental costs for CEP, spreading these costs proportionately to energy savings further reduces the cost effectiveness margin for CEP.
- **EEP:** The SCT ratio for EEP is 3.43 in 2021, an increase over the 2.85 ratio from in 2020. EEP was the most cost-effective program in the portfolio for 2021. However, it relies heavily on lighting and the role of lighting is expected to diminish as LEDs are required under changing federal standards.
- **Home Comfort**: The SCT ratio for Home Comfort is 1.66 in 2021 compared to 2.71 in 2020. The cost effectiveness decreased primarily due to the updates to incremental cost assumptions based on the evaluation team's research into actual project costs after subtraction of baseline measure costs.
- **REAP**: The SCT ratio for REAP is 0.74. Notably, cost-ineffectiveness is not unusual for income-qualified programs, which typically are not required to be cost-effective.
- **Home Performance**: The SCT for Home Performance is 0.58 in 2021 compared to 0.97 in 2020. The cost effectiveness for Home Performance is also affected by the evaluation team's 2021 research into the incremental cost of heat pumps.

- **HEM**: The SCT is 1.07 in 2021 compared to 1.23 in 2020. The cost effectiveness decreased relative to 2020 due to a relative increase in investment per participant and per MMBtu impact.

Figure 5: Societal Cost Test Ratios by Program

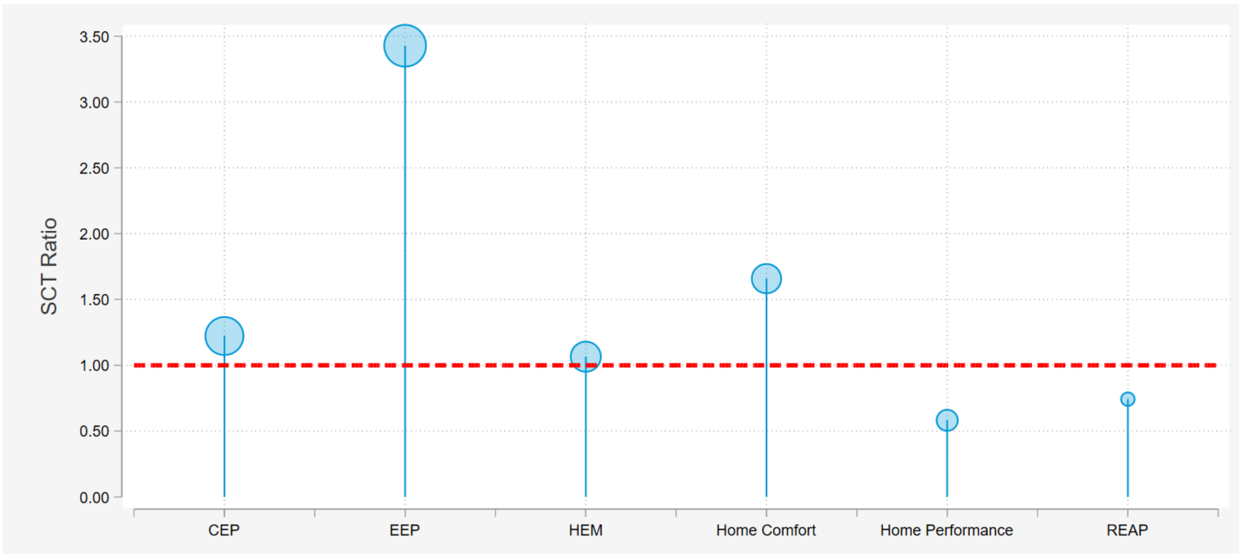
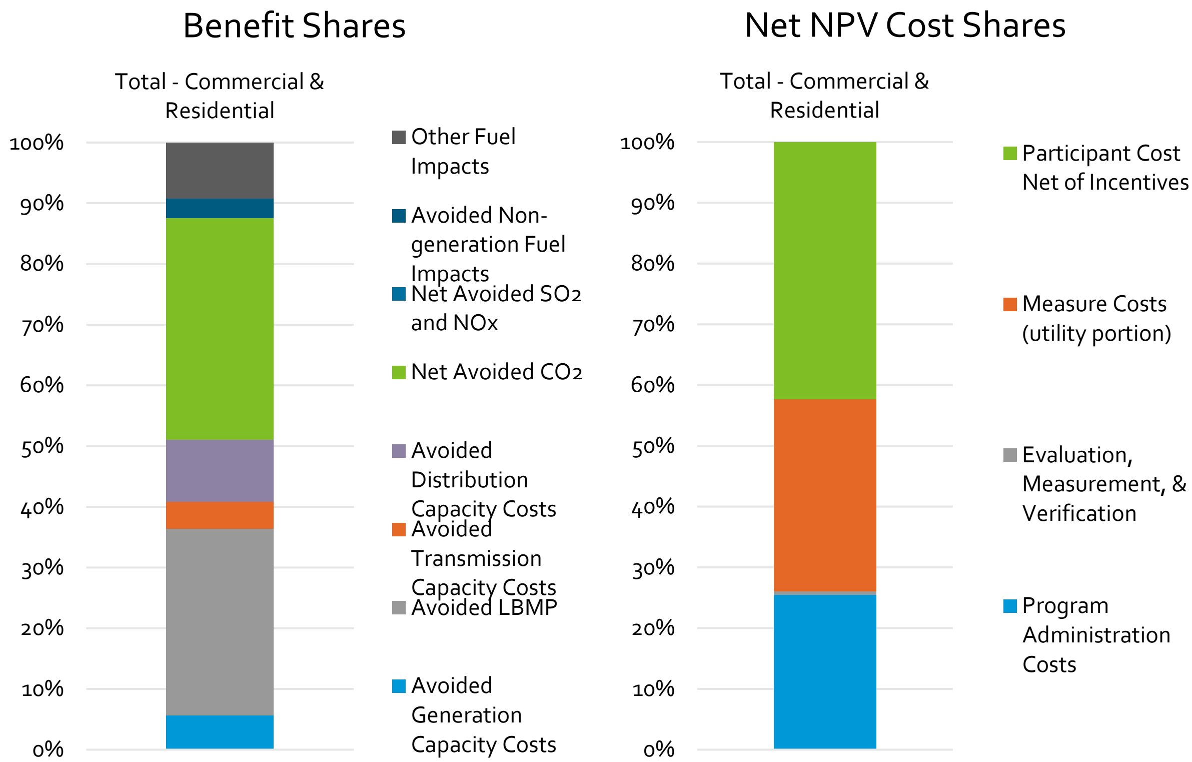


Figure 6 summarizes the benefit and cost categories analyzed and the share each contributed to the SCT. The primary two benefits for the SCT are avoided electric energy (LBMP) at 31% of benefits and avoided carbon emissions at 37% of benefits[3,4]. The combined benefits for capacity (generation, transmission, distribution) together comprise about 20% of societal benefits. From a societal perspective, the largest cost category is the measure costs borne by participants, followed by the measure costs borne by the utility in the form of customer rebates and contractor incentives. Together these two categories comprise the full incremental cost of efficiency measures over baseline measures. Program administration costs, including utility labor, advertising, and implementation vendor fees, comprise about 26% of societal costs.

[3] Carbon emission rate for electricity based on DPS "Order Adopting a Clean Energy Standard". http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=15-e-0302
[4] Carbon and particulate emission rates for fuels based on EPA AP-42 Quantification. https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors

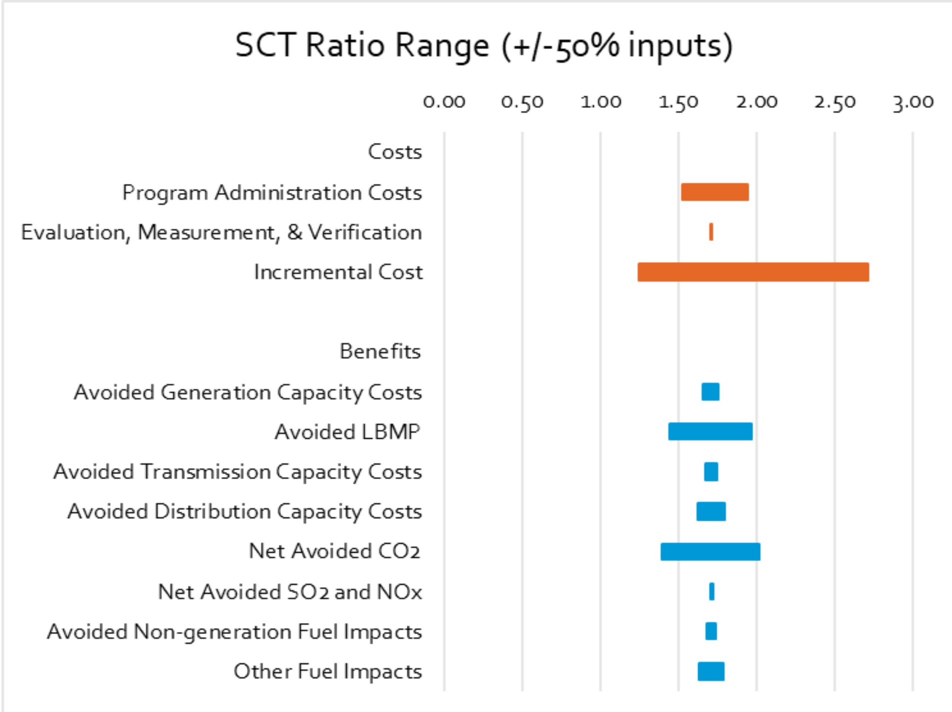
Figure 6: Portfolio Net Present Value Benefit and Cost Shares by Category



3.2 SENSITIVITY ANALYSIS

When considering the prospective implications of a cost-effectiveness analysis, it is important to assess how sensitive results may be to assumptions about cost and benefit inputs. Figure 7 shows the range of portfolio SCT ratios when each cost and benefit category is independently varied up and down by 50%. For example, if incremental costs were 50% higher the portfolio SCT would be about 1.25, but if incremental costs are 50% lower, the portfolio SCT ratio would be about 2.71. Similarly, if the avoided cost of carbon was 50% lower, the portfolio SCT would be 1.4, but if avoided carbon costs were 50% higher, the portfolio SCT ratio would be 2.0. The sensitivity analysis demonstrates that cost-effectiveness results are primarily driven by incremental cost assumptions, followed by assumptions regarding avoided electric energy and avoided carbon costs. The finding is logical given that these components comprise the largest shares of costs and benefits, respectively.

Figure 7: Efficiency Portfolio SCT Ratio Sensitivity to +/-50% Changes in Costs & Benefits



In addition to varying cost and benefit inputs up and down, an additional sensitivity analysis was conducted to explore the effects of declining carbon intensity of the power supply. As the electric generation mix decarbonizes, every MWh saved produces fewer avoided tons of CO_2. This means that it will be somewhat less cost-effective to save the same unit of electricity, holding all else constant. Conversely, every additional MWh consumed results in less CO_2 emitted than would have been the case at a higher emissions rate. This means that it will be somewhat more cost-effective to deploy beneficial electrification measures which result in increased electricity consumption.

The marginal carbon emissions rate is constant over time in the base scenario analysis. To explore sensitivity to declining emissions, marginal emissions were decreased annually to reach the carbon emissions rate implied by reaching the 70% renewables by 2030 goal of the Climate Leadership and Community Protection Act.[5] Table 5 shows the program and portfolio societal cost test results for this sensitivity scenario. Notably, while the portfolio SCT ratio drops from 1.71 to 1.44, the portfolio still passes the SCT. As expected, programs relying primarily on energy savings show modestly lower SCT ratios. In contrast, the Home Comfort program, which relies primarily on beneficial electrification, shows a modest increase in the SCT.

[5] https://climate.ny.gov/Our-Progress

Table 5: Societal Cost Test Results for Declining Emissions Sensitivity

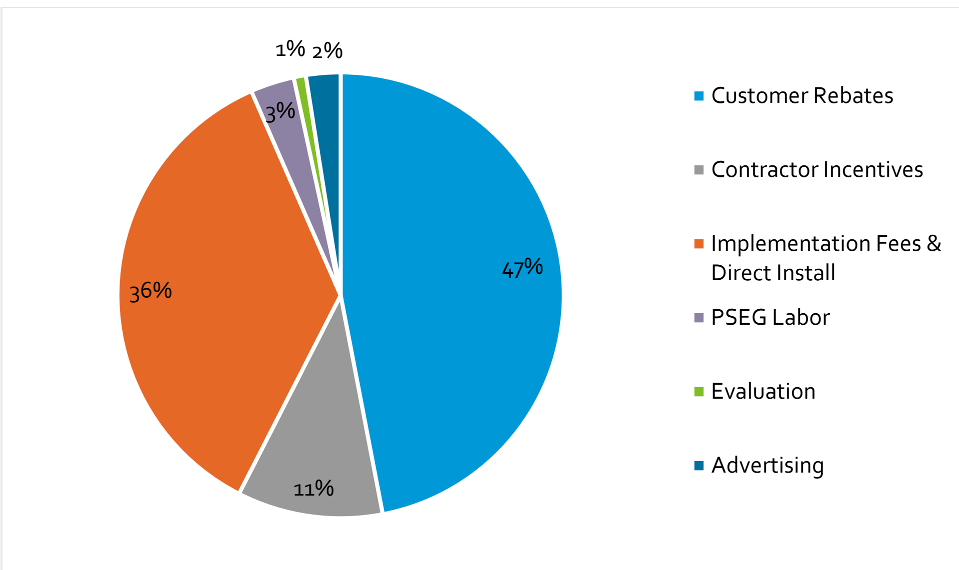
Sector	Program	NPV Benefits ($1,000)	Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$52,205	$51,982	1.00
Residential	Energy Efficient Products	$74,242	$28,264	2.63
	Home Comfort	$38,507	$22,243	1.73
	Residential Energy Affordability Partnership	$937	$1,517	0.62
	Home Performance	$7,781	$13,611	0.57
	Home Energy Management	$2,868	$2,691	1.07
Total Residential Portfolio:		**$145,695**	**$124,336**	**1.82**
Total Energy Efficiency Portfolio[1]:		***$209,250***	***$176,541***	***1.44***

[1] Portfolio costs include $1.87M of advertising that was not allocated to individual programs

3.3 2021 EXPENDITURE SUMMARY

PSEG Long Island spent $74.96 million on the Energy Efficiency and Beneficial Electrification Portfolio in 2021, compared to $79.6 million in 2020. Figure 8 summarizes the $74.96 million in spending related to implementation, management, and evaluation of energy efficiency programs in the 2021 Energy Efficiency and Beneficial Electrification Portfolio by type of expenditure. Customer "Rebates" consists of payments made to participating customers. Contractor "Incentives" consists of payments made to participating contractors (e.g., heating, ventilation, and air conditioning (HVAC) installers).

Figure 8: 2021 PSEG Long Island Expenditures for the Energy Efficiency and Beneficial Electrification Portfolio



3.4 ECONOMIC IMPACTS

Table 6 summarizes the estimated changes to Long Island's overall economic output and employment resulting from PSEG Long Island's 2021 Energy Efficiency Energy portfolio investments. Over 25 years, the 2021 investments in the Energy Efficiency Portfolio are expected to return $943.3 million in total economic benefits to the regional economy (in 2021 dollars), with an employment benefit of 1,297 full-time equivalent employees (FTEs)[6] over that time period.

Table 6: Economic Impact of 2021 Energy Efficiency and Beneficial Electrification Portfolio Investments

2021 Portfolio Investments		2021 Economic Impact	2021-2046 Economic Impact NPV[a]
Economic Impact	Total Economic Output	$172.0	$943.3
	Direct Effects	$162.5	$162.5
	Indirect & Induced Effects	$9.5	$780.7
	Employment FTE	466	1,297
Impact per $1M Investment	2021 Program Investment (Millions)	$75.0	$75.0
	Total Economic Output in Dollars per $1M Investment	$2.29	$12.58
	Employment (FTE) per $1M Investment	6.2	17.3

[a] Using nominal discount rate of 5.66%, based on PSEG Long Island Utility 2.0 filing assumptions.

Employment benefits are positively correlated to Program investment and to increased disposable income from participant energy cost savings. Program year 2021 FTEs declined to 466 from 484 in program year 2020 reflecting a corresponding 4.8% decrease in program investment. Program year 2021 participant energy cost savings over 25 years are projected to create 831 FTEs in addition to the 466 FTEs from Program investment, totaling 1,297 FTEs as shown in Table 6. By contrast, 646 additional FTEs were projected for Program Year 2020 because the corresponding participant energy costs savings were 30% lower than for Program Year 2021.

The effective useful lives of the measures installed in Program Year 2021 generally ranged from five years to 25 years. The notable exception is HEM, which is treated as having a one year EUL. The 25-year present value of participant energy costs savings was calculated separately and equaled $771.3 million. This present value was added to the 2021 Economic Impact of $172 million to total the 2021-2046 Economic Impact NPV of $943.3 million in Table 6. A discount rate of 5.66% and an energy price inflation rate of 1.67% were used to calculate the present value consistent with PSEG Long Island's assumptions for supply-side planning and the cost-effectiveness analyses.

The net present value of future economic impacts is comprised primarily of participant energy cost savings resulting from installation of energy efficiency measures in Program year 2021. The NPV

[6] Full-time equivalents represent the number of total hours worked divided by the number of compensable hours in a full-time schedule. This unit allows for comparison of workloads across various contexts. An FTE of 1.0 means that the workload is equivalent to a full-time employee for 1 year, but could be done, for example, by one person working full-time for a year, two people both working half-time for the year, or two people each working full-time for 6 months.

increased from $736.2 million in 2020 to $943.3 million in 2021 resulting from 18.0% higher MWH energy savings, 3.0% higher residential retail electricity prices and 12.8% higher commercial retail electricity prices in Program Year 2021.

4 TRENDS IN ENERGY EFFICIENCY AND BENEFICIAL ELECTRIFICATION

The Climate Leadership and Community Protection Act aims to:
Reduce Greenhouse gas emissions 40% by 2030 and 85% by 2050 below the 1990 emissions baseline.
Have 70% of energy come from renewable energy by 2030.
Achieve an energy efficiency target of 185 TBtu of cumulative site energy savings statewide.
Have 2 million climate friendly homes: 1 million electric and efficient & 1 million electrification ready.
Deploy 6 GW of Energy Storage capacity and 10 GW of solar by 2030.
Provide 35-40% of benefits of spending on clean energy and energy efficiency programs to disadvantaged communities.

New York has established several sweeping and ambitious statewide clean energy goals. Through the Climate Leadership and Community Protection Act (CLCPA), New York is doubling down on its efforts to create a clean, resilient, and equitable energy grid. As a result, PSEG Long Island will need to focus on expanding renewable energy resources, further electrifying and decarbonizing their system, reducing greenhouse gas emissions, and growing programs in disadvantaged communities.

PSEG Long Island was the first utility in the state to shift its primary performance metric to MMBtu to align with New York targets. This new performance metric created opportunities to pursue Beneficial Electrification measures, which PSEG Long Island first introduced in their 2020 Portfolio through measures like heat pump pool heaters and other HVAC improvements.

As a result of New York's push for electrification and decarbonization:

- New York State is projected to shift from a summer-peaking system to a winter-peaking system between 2030 and 2040 assuming heating and transportation are electrified. However, PSEG-LI's Integrated Resource Planning research suggests that Long Island will not become a winter-peaking system.
- A larger mix of Distributed Energy Resources (DERs) such as solar and wind will come online forcing the focus of planning to shift from planning for the gross peak load to planning for the net load peak – the load minus intermittent solar and wind.
- There is the potential for oversupply (where renewable supply is greater than baseload), especially in shoulder months in spring and fall.
- Ramping needs and fast response resources like battery storage will increase because of the intermittent nature of renewable generation.
- As the electric supply mix becomes more decarbonized, the avoided CO_2 per MWh saved will decrease. Considering the current avoided cost assigned to CO_2 emissions, this will

lower SCT benefits for energy efficiency, but increase SCT benefits from electrification measures.

Additionally, the US Department of Energy is proposing more stringent codes and standards under the Biden administration. Changing baselines will reduce the traditional energy efficiency opportunities available to programs. This will require program administrators to be nimble regarding eligible products to ensure the PSEG Long Island portfolio continues to push market transformation.

4.1 ECONOMICS OF ELECTRIFICATION

The economics of electrification are complex. Currently, natural gas generation is the predominant marginal generation source in downstate New York. This means that when a natural gas furnace is replaced by an electric heat pump, the primary shift is from fossil fuel combustion in the home to fossil fuel combustion at a power plant. From an emissions standpoint, this is useful because heat pumps are quite efficient at converting electricity to heat. However, as the electric generation mix includes more renewable resources on the margin, the differential in CO2 emissions will grow considerably. In the SCT results shown in Section 3.1, the CO2 emissions associated with an avoided (or added) kWh are based on the current electricity supply mix. Given aggressive climate policy goals in New York like the Climate Leadership and Community Protection Act, we expect the emissions rate of the grid to drop considerably over the next decade. As discussed in Section 3.2, a declining marginal emissions rate lowers the cost-effectiveness of energy efficiency but increases the cost-effectiveness of beneficial electrification programs.

In today's electric power system, the marginal cost of electricity is highly correlated with the cost of natural gas because natural gas is the dominant fuel source for power generation. This means global issues like the Ukraine-Russia war affect both sides of the ledger for electrification measures because the avoided fossil fuel is more valuable, but the added electric costs are also higher. As the electric generation mix decarbonizes, the marginal cost of electricity should become increasing decoupled from the avoided cost of fossil fuel.

The other key element in the economics of electrification is the value of avoided CO2 emissions. The social cost of carbon is ultimately a policy decision. In 2021, avoided CO2 emissions was the single largest benefits category (37% of all SCT benefits).

- The current social cost of carbon assumed in the PSEG Long Island Cost Effectiveness evaluation is $61.78 per metric ton, or $56.05 per short ton, and the portfolio SCT is 1.71.
- In neighboring Pennsylvania, the 2021 Act 129 Total Resource Cost Test Order[7] directs utilities to set the value at $0. If PSEG Long Island used an avoided cost of carbon of zero, the portfolio SCT would decrease to 1.09.

[7] https://www.puc.pa.gov/pcdocs/1648126.docx

- Meanwhile, the Avoided Energy Supply Cost Study Group for New England recommended $128 per short ton in their 2021 Avoided Energy Supply Component (AESC[8]) report.
    - In October 2021, that study was amended[9] to recommend a social cost of carbon of $393 per short ton. Massachusetts program administrators have adopted the $393 per short ton assumption in their 2022-2024 plan for energy efficiency and demand resources.
    - At $393 per short ton, the SCT ratio for PSEG Long Island's 2021 would be 4.64.
- In December 2020, New York State's Department of Environmental Conservation (DEC) published guidance that established a central cost of carbon of $125/metric ton, roughly $113/short ton. If the avoided cost of carbon was doubled to match this guidance, the portfolio benefit cost ratio would be 2.34.

The social cost of carbon is not a technical metric, it's a policy decision. As an evaluator we cannot determine which value is correct, but we would recommend PSEG Long Island review this key assumption with LIPA. It's an important driver of cost-effectiveness results for both energy efficiency and beneficial electrification.

4.2 TECHNOLOGICAL DEVELOPMENTS

4.2.1 HEAT PUMP TECHNOLOGY

The big push in electrification is the expansion of heat pumps for space heating and cooling, heat pump pool heaters, and heat pump water heaters. Heat pumps use electricity to move heat in buildings, and are considered beneficial electrification measures since they replace technologies like furnaces or boilers that burn fossil fuel to produce heat. With advancements in heat pump technologies, homes in cold climate regions, like Long Island, can rely on the heating capabilities of heat pumps through freezing temperatures in the winter.

Currently, the downstate New York grid is fairly carbon intense with 0.53846 tons of CO_2 per MWh[10]. This carbon intensive grid is expected to change rapidly with the CLCPA 70/30 goals, which sets the goal for New York to source 70% of its electric grid from renewable energy by 2030. As the power supply decarbonizes, measures that replace fossil fuel combustion at the home will be more beneficial from an emissions standpoint. For example, with the current carbon intense electric supply, when a heat pump replaces a furnace it shifts fossil fuel combustion at the home to electric consumption produced mostly by burning fossil fuel at the power plant. However, as the electric mix on the grid becomes cleaner, the electricity powering heat pumps will be have lower carbon emissions. At that point, replacing fossil fuel

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[8] Avoided Energy Supply Component/Cost (AESC) report PDFs can be found here: https://www.synapse-energy.com/project/avoided-energy-supply-costs-new-england-aesc

[9] https://www.synapse-energy.com/sites/default/files/AESC_2021_Supplemental_Study-Update_to_Social%20Cost_of_Carbon_Recommendation.pdf

[10] Assumed Marginal Emissions Rate (tons of CO_2/MWh) sourced from "Order Adopting a Clean Energy Standard" PDF from NY DPS: http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=15-e-0302

burned at the home will result in relatively less carbon emitted. As a result, the benefits of adding heat pump technology and other beneficial electrification measures will increase as the energy mix of the grid becomes cleaner.

4.2.2 Battery Storage

Increasingly, energy efficiency, battery storage, and demand response are used in T&D planning to avoid, defer, or reduce T&D infrastructure costs. Currently the energy efficiency portfolio does not fund battery storage or EVs. Any efforts to incentivize battery storage would likely be funded by PSEG Long Island's Utility 2.0 program, not through energy efficiency funding.

Behind the meter battery storage in Long Island is increasing. Battery storage is essential to de-carbonization because it allows the use of solar and wind energy during time periods when the sun is not shining, or the wind is not blowing. New York has incentives in place for battery storage and customers are increasingly adopting it, especially at the time of solar installation. Based on PSEG Long Island's interconnection data, roughly 10% of customer installing solar are also adding battery storage. Unlike other measures, battery storage also provides backup power to customers, which is increasingly beneficial given the increased frequency of severe storms.

Additionally, batteries that can be dispatched for grid needs can help stabilize the grid as more solar and wind resources come online. Batteries prove beneficial when the system is over-producing and excess energy production needs to be stored. Batteries are also effective ramping resources since they can dispatch their stored energy when needed, offsetting the intermittent nature of wind and solar.

4.2.3 Software-Based Measures

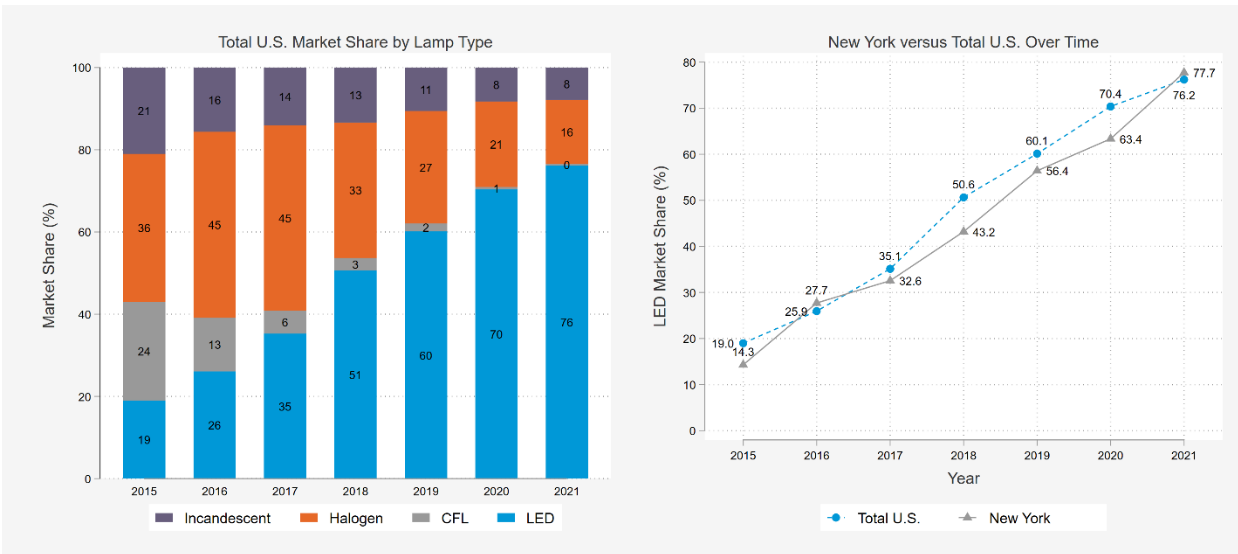
There are increasing opportunities for software-based measures such as thermostat optimization, building automation systems, and network lighting controls. Most smart thermostat optimization software aims to provide users with customized weather response that keeps the home comfortable while providing energy savings to the customer. This represents an opportunity for increased grid management control and energy savings, but it also presents an implementation challenge compared to the traditional equipment-based energy efficiency accounting practices. However, as more customer AMI data becomes available, through the expansion of smart thermostats and smart meters, it will give PSEG Long Island the ability to conduct continuous evaluation of various program measures.

AMI expansion also provides opportunities for performance-based programs and payments like pay-for-performance (P4P). With AMI data, utilities have been successful in implementing performance based programs with settlement at the meter. These types of programs allow for a more accurate representation of the value of energy saved by considering the market value of the delivered energy savings. Performance based programs offer more transparency to the end-use customer, increase flexibility in program design and incentive structures, and create a more accurate representation of Energy Efficiency impacts.

4.2.4 Future of Lighting Measures

Figure 9 below shows the increasing market share of screw-based LEDs over time. These figures were generated from data collected by the CREED lighting project[11]. The bar chart shows the change in technology shares nationally from 2015 through 2021. Over those years, New York's LED market share increased from 14% to 77%. In 2021, New York had a higher LED market share than the United States for the first time since 2016. Figure 9 shows how successful retail lighting programs like EEP have been transforming the retail lighting market, but also suggests that New York is fast approaching LED market saturation.

Figure 9: LED Market Share (2015-2021)



One of the largest potential shifts in program planning is the eventual phase out of LED lighting measures. Approximately 53% of PSEG Long Island's ex-post gross MMBtu savings in 2021 came from lighting measures in homes and businesses. In April 2022, the US Department of Energy released its final rulemaking regarding the Energy Independence and Security Act (EISA) backstop provision. This standard establishes a baseline efficiency requirement of 45 lumens per Watt for most categories of general service light bulbs (A-lamps, reflectors, globes, candelabra) and effectively prohibits the sale of non-LED lamps. In an Enforcement Policy Statement,[12] the DOE lays out the timeline shown in Figure 10. This change drastically reduces the programmatic savings available to PSEG Long Island from residential lighting within EEP.

[11] CREED Lighting Tracker: https://www.creedlighttracker.com/

[12] https://www.energy.gov/sites/default/files/2022-04/GSL_EnforcementPolicy_4_25_22.pdf

Figure 10: EISA Backstop Enforcement Timeline

August 31, 2022
Effective Date

↓

September - December 2022
Progressive Enforcement

↓

January 1, 2023
Full enforcement for manufacturer and import

↓

July 2023
Full enforcement for retailers and distributors

While the EISA backstop provision has been discussed for many years, the final details regarding timing and enforcement were released very recently. PSEG Long Island will need to decide quickly how to reflect recent developments in its 2023 planning. Without the LED lighting component of EEP, the SCT ratio of the PSEG Long Island Portfolio is 1.18 (vs. 1.71). The EEP program SCT drops dramatically from 3.43 with lighting to 1.08 without lighting, but the program would remain cost effective from a societal standpoint even without lighting. In 2021, EEP Lighting accounted for 64% of ex-post gross MMBtu savings in the residential sector. Not only is LED lighting the largest contributor of savings, but it is also the lowest cost measure in terms of program expenditure per unit of energy saved. There simply is not another measure in the residential portfolio to fill the vacuum. If residential spending stays constant the expected annual savings will go down without lighting. It's unclear that historic levels of residential savings are achievable without LED lighting, even with a large increase in budget.

4.3 EMPHASIS ON DISADVANTAGED COMMUNITIES

New York's Climate Leadership and Community Protection Act (CLCPA) established that utilities are to ensure that at least 35% of the benefits of spending on clean energy and energy efficiency programs go to disadvantaged communities, with a goal of 40%. This goal will be a major factor in shaping future Portfolio planning efforts. The most recent criteria for identifying Disadvantaged Communities (DACs) and low-income households, presented by the Climate Justice Working Group, utilizes both census track indicators and income limits based on the statewide median income. Even under the expanded definition, just 25% of Long Island households are flagged in DACs or as low-income households. Long

Island may be the only region in the state with less than 35% of households qualifying under these conditions. A smaller target group presents significant challenges to meet the standards established in the CLPCA, and PSEG Long Island will have to establish innovative ways to effectively target these communities.

4.4 CONTINUING IMPACT OF COVID-19

COVID19 undoubtedly played a role in the 2020 program year, halting all in-person measure implementations for months, however PSEG Long Island was successful in quickly ramping up program implementation efforts and onsite activities as soon as it was safe to do so. The question now is how has COVID continued to impact the energy efficiency efforts? With different waves like Delta and Omicron, customer behavior and program implementation went through many changes throughout 2021. With Long Island residents spending more time in their homes, we wonder if this might drive more efforts in home improvement projects such as pool installations. Has the current housing boom touched Long Island, and what kind of opportunities does an influx of new homeowners provide for Energy Efficiency Programs?

We expect a certain amount of program processes will remain virtual/remote rather than in-person based on successes during the pandemic. This could lead to cost savings for PSEG Long Island. The pandemic's long-term effects on the economy, energy use patterns, and customer demand for efficiency are harder to forecast. Many businesses are planning to retain increased work-from-home options indefinitely, which will have implications for load patterns and housing demand on Long Island. Commercial building operators will have a keen interest in air quality and other safety measures, which may generate program opportunities for HVAC measures.

APPENDIX A ABBREVIATIONS

ASHP	Air-source heat pump
BTU	British Thermal Unit
CEP	Commercial Efficiency Program
CF	Coincidence Factor
CHP	Combined Heat and Power
CLCPA	Climate Leadership and Community Protection Act
DER	Distributed Energy Resource
DHW	Domestic hot water
EEP	Energy Efficiency Products
EISA	Energy Independence and Security Act
EPA	U.S. Environmental Protection Agency
FR	Free Ridership
FTE	Full-Time Equivalent Employees
GSHP	Ground-source heat pump
HEM	Home Energy Management
HER	Home energy report
HPwES	Home Performance with Energy Star
kW	Kilowatt
kWh_{ee}	Kilowatt Hour Energy Efficiency
kWh_{be}	Kilowatt Hour Beneficial Electrification
kWh	Kilowatt Hour
MMBtu	Million British thermal unit
$MMBtu_{ee}$	Million British thermal unit Energy Efficiency
$MMBtu_{be}$	Million British thermal unit Beneficial Electrification
LED	Light-Emitting Diode
LIPA	Long Island Power Authority
LMI	Low- to moderate-income
NEB	Non-Energy Benefit
NTGR	Net-to-Gross Ratio
NYSERDA	New York State Energy Research and Development Authority
RIM	Ratepayer Impact Test
REAP	Residential Energy Affordability Partnership
REV	Reforming the Energy Vision
SCT	Societal Cost Test
SO	Spillover
TRM	Technical Reference Manual
UCT	Utility Cost Test
VEA	Verified Ex -Ante
VFD	Variable frequency drive

APPENDIX B ELECTRICITY ENERGY (KWH) AND DEMAND SAVINGS (KW)

Although the primary reporting metric for 2021 evaluation results is on total site-level MMBtu savings for consistency with goals, we also report fuel-specific results for several reasons.

- PSEG Long Island is an electric utility, so the MWh and MW impacts of the Portfolio have discrete implications for a host of forecasting and system planning functions.
- Consistency with prior reports. We believe it is important for readers to have the ability to compare the results of the 2021 evaluation with prior evaluations.
- While site-level MMBtu is useful as a single metric for all conservation programming, the benefit-cost analysis requires us to keep track of resources separately. The avoided cost of one delivered MMBtu of electricity is much higher than the avoided cost of one MMBtu of fossil fuel. The emissions per MMBtu also vary by resource because generators combust 2-3 MMBtu of fossil fuel to generate power[13] to deliver one MMBtu of electricity to a Long Island home.

While the evaluation team elected to report fuel-specific results, we highlight that due to beneficial electrification, measures that reduce fossil fuel use but increase electricity consumption and demand, some program MWh and kW impact results report negative electricity savings.

[13]The marginal unit in downstate New York will typically be a combined-cycle natural gas plant or a natural gas combustion turbine. According to EIA data https://www.eia.gov/electricity/annual/html/epa_08_02.html the average heat rate of these two generator types are 7,633 Btu/kWh and 11,098 Btu/kWh respectively. This translates to a thermal efficiency of 44.7% and 30.7%.

Table 7: Total Energy Efficiency and Beneficial Electrification Program MWh Impacts

Sector	Energy Efficiency Program	Ex-Ante Gross Savings (Claimed[1])	Ex-Post Gross Savings (Evaluated)	Ex-Post Net Savings
		MWh	MWh	MWh
Commercial	Commercial Efficiency Program	109,468	103,255	83,060
Residential	Energy Efficiency Products	221,340	183,607	113,797
	Home Comfort	(6,651)	(8,352)	(7,966)
	Home Performance	886	885	705
	Home Energy Management	40,037	31,198	33,073
	Residential Energy Affordability Program	1,618	1,366	1,448
	Subtotal Commercial:	109,468	103,255	83,060
	Subtotal Residential:	257,231	208,703	141,057
	Total Energy Efficiency Portfolio:	**366,699**	**311,959**	**224,117**

[1] MWh Ex-Ante Gross Savings (Claimed) in table might not match KPI scorecard values. Table values include all Energy Efficiency Savings as well as negative MWh savings from Beneficial Electrification, while KPI scorecard reports Energy Efficiency Savings only.

Table 8: Total Energy Efficiency and Beneficial Electrification Program kW impacts

Sector	Energy Efficiency Program	Ex-Ante Gross Savings (Claimed[1])	Ex-Post Gross Savings (Evaluated)	Ex-Post Net Savings
		kW	kW	kW
Commercial	Commercial Efficiency Program	19,723	19,405	15,595
Residential	Energy Efficiency Products	34,608	27,568	17,692
	Home Comfort	531	279	286
	Home Performance	485	754	601
	Home Energy Management[2]	n/a	8,692	9,365
	Residential Energy Affordability Program	298	211	228
	Subtotal Commercial:	19,723	19,405	15,595
	Subtotal Residential:	35,922	37,504	28,171
	Total Energy Efficiency Portfolio:	**55,644**	**56,908**	**43,766**

[1] kW Ex-Ante Gross Savings (Claimed) in table might not match KPI scorecard values. Table values include all Energy Efficiency Savings as well as Beneficial Electrification, while KPI scorecard reports Energy Efficiency Savings only.

[2] HEM kW savings are not claimed by PSEG-LI.

APPENDIX CADDITIONAL COST-EFFECTIVENESS PERSPECTIVES AND METRICS

In New York, the primary metric for screening portfolios for cost-effectiveness is the Societal Cost Test (SCT), which includes benefits accrued to New York as a whole. The perspective enables New York to factor in the societal benefits of reduced emissions as well as the avoided costs of energy production and delivery. It also enables the inclusion of beneficial electrification technologies that increase electricity use but lead to overall lower energy consumption or reduced carbon impacts by shifting energy use from fossil fuels (fuel oil, propane, and natural gas) to electricity.

We also report the Utility Cost Test (UCT).[14] The tests are similar in most respects but consider slightly different benefits and costs in determining a benefit/cost ratio. The UCT measures the net costs of an energy efficiency program as a resource option based on the costs incurred by the program administrator, including all program costs and any rebate and incentive costs, but excludes costs incurred by the participant. The UCT only includes benefits that accrue to the utility and therefore does not include the benefits of non-electric (i.e., gas and fuel oil) energy savings or increases, or emissions of carbon or particulates. Because both costs and benefits are different than those considered from the societal perspective, the UCT benefit-cost ratio is also different.

As shown in Table 9, the UCT was 1.43 for the Energy Efficiency and Beneficial Electrification Portfolio. This indicates that the portfolio is also cost-effective from the utility perspective. Notably, the Home Comfort UCT ratio was negative, indicative of the increase in electricity associated with electrification measures such as heat pumps. Essentially, the net benefits from the utility perspective are negative. While electrification produces societal benefits in the form of reduced carbon emissions and reduced non-electric fuel consumption (e.g., natural gas and fuel oil), it increases electricity consumption to serve the newly electrified end uses. From the perspective of an electric utility, such as PSEG Long Island, the increased electricity costs are not offset by fuel and carbon reductions which only accrue from the societal perspective. In contrast, the Home Comfort SCT ratio is 1.66 indicating that from the societal perspective benefits do outweigh costs associated with this program comprised primarily of electrification measures.

[14]The Utility Cost Test is also commonly known as the Program Administrator test.

Table 9: Utility Cost Test Results for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	NPV Benefits ($1,000)	NPV Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$44,505	$33,070	1.35
Residential	Energy Efficient Products	$61,041	$20,544	2.97
	Home Comfort	($2,503)	$10,650	-0.24
	Residential Energy Affordability Partnership	$712	$1,517	0.47
	Home Performance	$1,174	$4,372	0.27
	Home Energy Management	$1,846	$2,691	0.69
	Subtotal Residential Efficiency Portfolio:	**$62,270**	**$39,774**	**1.57**
	Total Energy Efficiency Portfolio[1]:	***$106,776***	***$74,718***	***1.43***

[1] Portfolio costs include $2M of advertising that was not allocated to individual programs

Another relevant metric in the context of electrification measures is the Ratepayer Impact test (RIM). This test considers the perspective of non-participating ratepayers and reflects the impact of programs on rates. The benefits and costs considered are like those considered from the utility perspective in that participant costs and societal benefits are not considered. The key difference is that changes in utility revenue are considered and increases in revenue are a considered as a benefit. This is the key component for assessing the impact on rates. Electricity rates are determined in part by allocating the fixed costs of maintaining and operating the electric grid across ratepayers. The primary metric for allocating costs across most rate payers is consumption as measured by kWh. Because consumption is the denominator for determining rates average rates increase as total consumption decreases, and average rates decrease as total consumption increases. To the extent that energy efficiency results in reduced consumption, it places upward pressure on rates while electrification places downward pressure on rates by increasing total consumption.

As shown in Table 10, the RIM was 0.22 for the Energy Efficiency and Beneficial Electrification Portfolio. This indicates that the portfolio is not cost-effective from the ratepayer perspective. This is to be expected since most of the portfolio is comprised of energy efficiency measures which decrease consumption. In contrast, Home Comfort was the only program with a RIM ratio greater than 1.0, indicative of the increase in electricity associated with electrification measures such as heat pumps. Essentially, the net benefits for electrification from the ratepayer perspective are positive in this case, after factoring in program costs.

Table 10: Ratepayer Impact Test Results for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	NPV Benefits ($1,000)	NPV Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$44,505	$253,568	0.18
Residential	Energy Efficient Products	$62,412	$333,845	0.19
	Home Comfort	$23,699	$13,661	1.73
	Residential Energy Affordability Partnership	$712	$5,005	0.14
	Home Performance	$1,174	$6,532	0.18
	Home Energy Management	$1,846	$9,828	0.19
	Total Residential Efficiency Portfolio	**$89,843**	**$368,872**	**0.24**
	Total Energy Efficiency Portfolio	***$134,349***	***$624,314***	***0.22***

In addition to benefit-cost ratios, there are two metrics which can be of value for assessing the performance of a program or portfolio. These are the first-year or acquisition cost of energy and the levelized or lifetime cost of energy. In budget planning and goal setting, the planned budget is compared to planned gross energy impacts (which do not include line losses or net to gross ratios). The actual first-year cost is comparable to this planning metric in that it compares actual spending to actual gross energy impacts. Importantly, gross impacts are considered to ensure comparability to planned budgets and energy targets. Table 11 shows the first-year cost for demand (kW), electricity (kWh), and the energy agnostic MMBtu planning metric. Both the utility and societal perspective are shown. The difference between the two is that the societal perspective includes the full incremental measure costs. Program or portfolio acquisition costs can be compared with acquisition costs for other utility programs or portfolios. As with the UCT benefit cost ratio, the first-year cost per kWh for the Home Comfort program is negative. This is the nature of electrification measures that increase rather than reduce electricity consumption.

Table 11: First Year Costs for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	2021 Ex-Post Gross UCT First-Year Acquisition Cost			2021 Ex-Post Gross SCT First-Year Acquisition Cost		
		$/MMBtu	$/kW-year	$/kWh	$/MMBtu	$/kW-year	$/kWh
Commercial	Commercial Efficiency Program	$154.96	$1,704	$0.32	$304.01	$3,343	$0.63
Residential	Energy Efficient Products	$40.40	$841	$0.12	$79.67	$1,659	$0.23
	Home Comfort	$101.96	$38,158	($1.28)	$232.29	$86,936	($2.91)
	Residential Energy Affordability Partnership	$371.20	$7,198	$1.11	$371.20	$7,198	$1.11
	Home Performance	$149.28	$5,826	$4.94	$572.29	$22,336	$18.94
	Home Energy Management	$25.28	$310	$0.09	$25.28	$310	$0.09
	Subtotal Residential Portfolio:	**$52.84**	**$1,158**	**$0.20**	**$113.90**	**$2,496**	**$0.42**
	Total Portfolio:	***$77.33***	***$1,390***	***$0.24***	***$157.83***	***$2,837***	***$0.50***

Levelized cost is another useful metric which essentially divides costs by the lifetime net energy impacts (which include line losses and net to gross ratios). Net impacts are used to compare the cost of energy efficiency programs more directly with energy or capacity costs from other sources. Because levelized costs are expressed as $/kW-year and $/kWh, planners can readily compare them to the cost of alternative supply options. Table 12 shows the levelized cost for demand (kW), electricity (kWh), and the energy agnostic MMBtu planning metric. Both the utility and societal perspective are shown. The difference between the two is that the societal perspective includes the full incremental measure costs. Levelized costs can be compared with marginal costs for other resources. As with the UCT benefit cost ratio, the levelized cost per kWh for the Home Comfort program is negative. This is the nature of electrification measures that increase rather than reduce electricity consumption.

Table 12: Levelized Costs for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	2021 Ex-Post Net UCT Levelized Costs			2021 Ex-Post Net SCT Levelized Costs		
		$/MMBtu	$/kW-year	$/kWh	$/MMBtu	$/kW-year	$/kWh
Commercial	Commercial Efficiency Program	$21.70	$209	$0.04	$34.11	$328	$0.06
Residential	Energy Efficient Products	$5.75	$115	$0.02	$7.91	$158	$0.02
	Home Comfort	$9.66	$3,057	($0.11)	$20.17	$6,385	($0.24)
	Residential Energy Affordability Partnership	$34.63	$666	$0.10	$34.63	$666	$0.10
	Home Performance	$15.87	$578	$0.50	$49.39	$1,800	$1.55
	Home Energy Management	$23.85	$287	$0.08	$23.85	$287	$0.08
Subtotal Residential Portfolio:		**$7.78**	**$197**	**$0.03**	**$13.37**	**$339**	**$0.06**
Total Portfolio:		***$11.26***	***$208***	***$0.04***	***$18.42***	***$339***	***$0.06***

APPENDIX D VERIFIED EX-ANTE MEMO

MEMORANDUM 2021 VERIFIED EX-ANTE SAVINGS

Date: January 31, 2022

To: Dan Zaweski, Joseph Fritz-Mauer, and Ashley Kaleita (PSEG Long Island)

From: 2021 Evaluation Team (Demand Side Analytics, DNV, and Mondre Energy)

Re: 2021 Verified Ex-Ante Savings for Energy Efficiency and Beneficial Electrification Programs

Background

PSEG Long Island asked the Demand Side Analytics evaluation team to verify ex-ante energy savings as part of its evaluation of PSEG Long Island's 2021 energy efficiency and beneficial electrification programs. This memorandum defines "verified ex-ante" (VEA) savings and presents the 2021 verified ex-ante savings for each program.

Definition of Verified Ex-Ante

The verified ex-ante calculations seek to answer the question, "were the ex-ante gross energy impacts claimed by the implementation contractors calculated consistently with approved calculations and assumptions?" To answer this question, we independently calculated program impacts using the methods and assumptions approved by PSEG Long Island and compared the results to the ex-ante gross values submitted by the implementation contractor (TRC). The ratio of these two values is the verified ex-ante realization rate.

The details of the verified ex-ante calculations vary by program and measure. Some measures were assigned static per-unit impacts in the 2021 assumptions, so the verified ex-ante calculation only requires counting the number of units stored in the program tracking data and multiplying that total by the per-unit savings planning assumption. Other measures are more dynamic and require the use of algorithms and project-specific parameter values. Additionally, throughout the program year improvements to the assumptions were proposed by TRC and approved by PSEG-LI. These new assumptions were used to calculate verified ex-ante where applicable.

The verified ex-ante savings are the first milestone of the 2021 evaluation. They are a separate and distinct performance metric from the evaluated ex-post savings, which will be delivered later this spring. Both the claimed ex-ante and verified ex-ante savings are expressed on a gross basis – meaning they do not reflect adjustments for net-to-gross factors or line losses.

Results

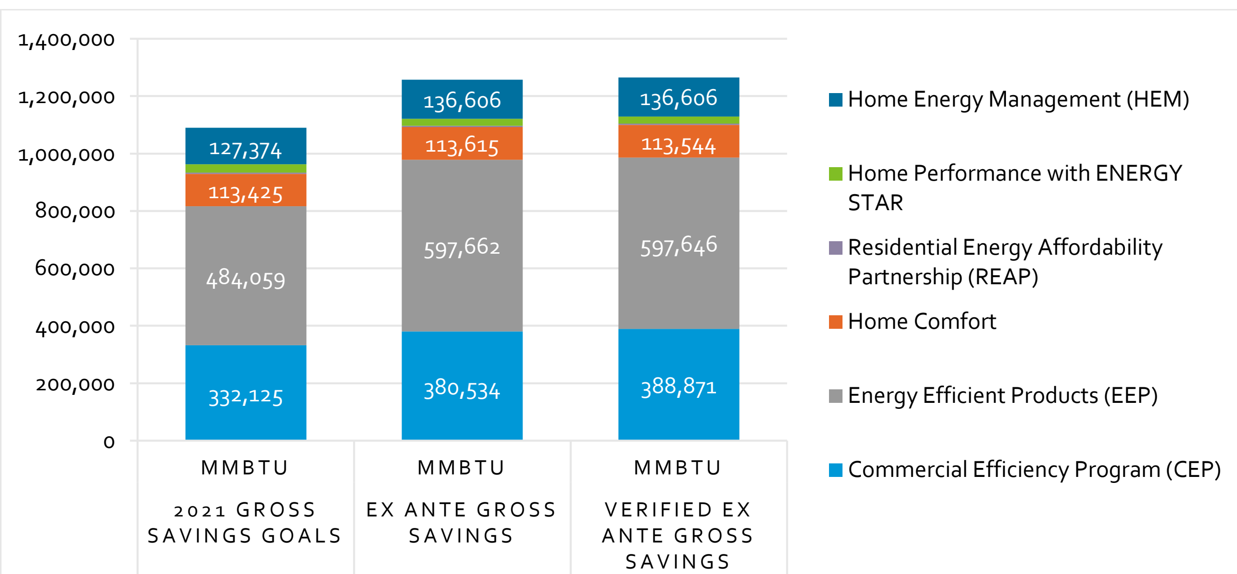
Table 1 summarizes the 2021 verified ex-ante savings for MMBtu. The verified ex-ante savings were 100.7% of the claimed ex-ante gross savings. The evaluation team's independent measure counts were nearly identical to the claimed measure counts. Per-unit MMBtu savings calculations and assumptions matched the approved values almost perfectly for nearly all measures. In 2021, 6,722 heat pumps were claimed to be installed through the Home Comfort, EEP, Home Performance, and CEP programs. We can confirm that we have counted the same number of heat pumps as TRC.

TABLE 1: SUMMARY OF 2021 VERIFIED EX-ANTE MMBTU SAVINGS AND GOALS

Program		2021 Gross Savings Goals	Ex-Ante Gross Savings	Verified Ex-Ante Gross Savings	Verified Ex-Ante Realization Rate	Verified as % of Goals
		MMBTU	MMBTU	MMBTU	%	%
Commercial	Commercial Efficiency Program (CEP)	332,125	380,534	388,871	102.2%	117.1%
Residential	Energy Efficient Products (EEP)	484,059	597,662	597,646	100.0%	123.5%
	Home Comfort	113,425	113,615	113,544	99.9%	100.1%
	Residential Energy Affordability Partnership (REAP)	4,532	4,648	4,650	100.0%	102.6%
	Home Performance	28,760	24,307	24,307	100.0%	84.5%
	Home Energy Management (HEM)	127,374	136,606	136,606	100.0%	107.2%
Total Commercial:		**332,125**	**380,534**	**388,871**	**102.2%**	**117.1%**
Total Residential:		**758,150**	**876,838**	**876,753**	**100.0%**	**115.6%**
Total Energy Efficiency and Beneficial Electrification:		**1,090,275**	**1,257,372**	**1,265,623**	**100.7%**	**116.1%**

Figure 1 below shows that the Energy Efficiency Program, Commercial Efficiency Program, and Home Energy Management program were the top three contributing programs, together comprising 89% of verified ex-ante savings in 2021.

FIGURE 1: MMBTU CONTRIBUTIONS BY PROGRAM



Additionally, we developed a verified ex-ante savings metric for comparison with the established annual savings goals. The portfolio verified ex-ante gross savings were 116.1% of the 2021 savings goals, exceeding PSEG Long Island's goals by 175,348 MMBtu. Home Performance with ENERGY STAR is the only program that fell short of planning goals. There is an ongoing investigation into the HPwES projects claimed by one contractor. Those projects were removed from both the verified and claimed ex ante savings bringing the overall program savings below planning goals.

Appendix A: MWh and MW VEA Results

As previously explained, both the claimed ex-ante and verified ex-ante savings are expressed on a gross basis. This means they do not reflect adjustments for net-to-gross factors or line losses. The primary reporting metric for 2021 VEA is Gross MMBtu savings. Gross MMBtu is the sum of MMBtu Beneficial Electrification ($MMBtu_{be}$) savings and MMBtu Energy Efficiency ($MMBtu_{ee}$) savings.

In Table 2 below we report the claimed ex-ante and verified ex-ante MWh savings. Gross MWh savings in this context, is just the MWh Energy Efficiency (MWh_{ee}) value. MWh Beneficial Electrification (MWh_{be}) impacts are not considered in the ex-ante savings. This is different from the ex-post evaluation where we will report delta MWh impacts. Delta MWh is the difference between MWh_{ee} and MWh_{be}.

TABLE 2: SUMMARY OF 2021 VERIFIED EX-ANTE MWH SAVINGS

Program		Claimed Ex-Ante Gross Savings	Verified Ex-Ante Gross Savings	Verified Ex-Ante Realization Rate
		MWh_{ee}	MWh_{ee}	%
Commercial	Commercial Efficiency Program (CEP)	109,320	108,472	99.2%
Residential	Energy Efficient Products (EEP)	224,228	224,225	100.0%
	Home Comfort	2,544	2,540	99.8%
	Residential Energy Affordability Partnership (REAP)	1,618	1,619	100.1%
	Home Performance	1,602	1,602	100.0%
	Home Energy Management (HEM)	40,037	37,331	93.2%
Total Commercial:		**109,320**	**108,472**	**99.2%**
Total Residential:		**270,030**	**267,317**	**99.0%**
Total Energy Efficiency and Beneficial Electrification:		**379,350**	**375,789**	**99.1%**

Table 3 below reports claimed ex-ante and verified ex-ante peak demand (MW) values. Ex-ante MW values are not scaled for transmission and distribution losses.

TABLE 3: SUMMARY OF 2021 VERIFIED EX-ANTE MW SAVINGS

Program		Claimed Ex-Ante Gross[a] Savings	Verified Ex-Ante Gross[a] Savings	Verified Ex-Ante Realization Rate
		MW	MW	%
Commercial	Commercial Efficiency Program (CEP)	19.72	20.36	103%
Residential	Energy Efficient Products (EEP)	34.61	34.61	100%
	Home Comfort	0.53	0.53	100%
	Residential Energy Affordability Partnership (REAP)	0.28	0.27	98%
	Home Performance	0.49	0.49	100%
	Home Energy Management (HEM)[b]	n/a	n/a	n/a
	Total Commercial:	**19.72**	**20.36**	**103%**
	Total Residential:	**35.90**	**35.90**	**100%**
	Total Energy Efficiency and Beneficial Electrification:	**55.63**	**56.26**	**101%**

[a] Line Loss Factors are not applied in claimed or verified ex-ante MW.
[b] PSEG-LI does not claim MW savings for HEM, so we did not calculate ex-ante MW savings for this program. MW savings will be provided in the ex-post evaluation.

Appendix B: Supplemental Detail

The evaluation team verified the calculations and inputs for hundreds of measures and inputs. The below table includes additional detail on nuances observed in the Captures data as well as the calculations and assumptions used.

Program	Sub-Component	Description	Implications
Commercial Efficiency Program	Comprehensive Lighting	In the 2020 ex post evaluation, we developed HVAC interactive factors for PSEG LI. In Q4, TRC started to apply these HVAC interactive factors resulting in a decrease in claimed savings for that quarter. We calculated verified ex-ante savings using the planning assumptions, which did not include waste heat factors.	A 106% MMBtu realization rate for comprehensive lighting measures.
	Fast Track Lighting	TRC's calculation workbook applied both demand and energy waste heat factors to energy savings calculations (both kWh and MMBtu) for over 70% of projects. This issue was fixed in 2021 Commercial Master Internal Workbook v1.1 and later.	Fast Track Lighting MMBtu realization rate of 84%.
	Refrigerated Case Lighting	TRC applied PSEG 2010 assumptions, based on the 2010 NYS Tech Manual. Planning spreadsheet recommended an algorithm based on NYS TRM v7.	Refrigerated Case Lighting constituted 2% of overall CEP lighting savings.
	Custom Projects	In 2015/2016, ODC conducted a review of CEP Custom projects and produced a deemed realization rate of 96% for kWh. For 2021 VEA, we decided not to apply legacy adjustments.	A 100% MMBtu realization rate.
		70% of custom MMBtu comes from one project. The claimed savings for that project is 50% of its total expected contribution with the full balance to be claimed in 2022.	We will want to work with TRC on the M&V approach for this project.

Program	Sub-Component	Description	Implications
EEP	LED Standard and Specialty Lighting	▪ Lighting in-service rate is applied in a different stage of the planning calculations workbook for MMBtu, kWh EE, and kW metrics, and the kW calculations differ between Standard and Specialty LEDs.	▪ No impact on VEA as ISRs are eventually applied correctly to all metrics. We recommend a minor update to standardize ISR calculations to minimize chances of errors in future planning tasks.
Home Performance	Home Performance with ENERGY STAR	▪ There were 510 projects by Green Seal Weatherization in 2021. 504 of these projects are still under investigation, so their savings (4,999 MMBtu) were removed from KPI totals.	▪ If these savings are ultimately included in ex-ante, the Home Performance program would exceed goals for 2021.
	Home Performance with ENERGY STAR	▪ Savings calculations for HPwES measures require home heating system/fuel. This information is not available as a query field in Captures, only available in individual project workbooks.	▪ Line-by-line savings replication is not feasible. We assigned HPwES measures 100% VEA realization rates after reviewing the savings calculations in a sample of application workbooks.
	HPDI Lighting	▪ Approved TRC workbook assumptions were used to calculate claimed ex-ante savings. These new assumptions increased calculated lighting savings by 16% compared to planning assumptions.	▪ HPDI program exceeds program savings goals.
REAP	Lighting	▪ Approved TRC workbook assumptions were used to calculate claimed ex-ante savings rather than planning assumptions. If planning assumptions were used, REAP lighting savings would have been 20% lower.	▪ REAP program exceeds program savings goals.